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Dated 2 August 2004

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

- 2 APR 2004

The Patent Office
Cardiff Road
Newport
South Wales
NP9 1RH

1. Your reference — XLT 100

2. Patent application number
(The Patent Office will fill in this part) — 0407600.6

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Phil Head
Gibbs House
Kennel Ride
Ascot
Berks SL5 7NT

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation — 8738627001

4. Title of the invention

Well Dewatering System

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

Hillgate Patent Services
No. 6 Aztec Row
Berners Road
Islington
London N1 0PW

Patents ADP number *(if you know it)* — 5953112002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

No

Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	—
Description	9
Claim(s)	3
Abstract	—
Drawing(s)	2 + 2

10. If you are also filing any of the following, state how many against each item.

Priority documents	—
Translations of priority documents	—
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	—
Request for a preliminary examination and search (Patents Form 9/77)	—
Request for a substantive examination (Patents Form 10/77)	—
Any other documents (please specify)	—

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Hillgate Patent Services Date 2/4/04

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom PAUL HARMAN 020 7704 5748

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 19[illegible] stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 08459 500505.

b) Write your answers in capital letters using black ink or you may type them.

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Well dewatering system

The present invention relates to removing liquids from a gas producing well.

Liquid-phase material is often present in underground gas reservoirs, either as condensation of hydrocarbon gas, or, particularly from coalbed gas wells, as water. The accumulation of liquid in the well imposes a back pressure which reduces the rate of gas production, and can kill a low pressure well.

Initially, the pressure of the well may be sufficient to carry the liquid and gas to be carried up the well together. However, the well pressure may not be sufficient for this, or it may be desired to remove liquid separately from the well for other reasons. Periods were the well must be dewatering typically last between six months and three years. One method of dewatering a well is to introduce a siphon pipe between the accumulated liquid and the surface of the well. However, the pressure of the well may be insufficient to carry liquid up the siphon quickly enough, and the accumulated liquid may build up, so reducing the gas production.

The object of the invention is to provide a convenient an effective way of removing liquids from a well.

According to the present invention there is provided a system for removing liquid from a portion of a borehole, comprising

a motor;

a pump;

a tube disposed within the borehole so as to define an annulus between the outer surface of the tube and the wall of the borehole

a packer sealedly separating the annulus above the packer from the lower part of the borehole,

such that gas may be produced up the bore of the tube, and liquid may be pumped into the annulus above the packer.

Preferably the motor and pump may be moved along the tube.

According to another aspect of the present invention there is provided a system for removing liquid from a portion of a borehole, comprising

a tube disposed within the borehole so as to define an annulus between the outer surface of the tube and the wall of the borehole

and a sump packer sealing the sump of the borehole with the borehole above it

such that a motor and pump may be used to direct liquid in the borehole either up the annulus, or below the sump packer.

According to another aspect of the present invention there is provided a system for removing liquid from a portion of a borehole, comprising

a motor;

a pump;

a sump packer sealing the sump of the borehole with the borehole above it

the inlet of the pump being in fluid communication with the borehole above the sump packer, and the outlet of the pump being in fluid communication with the borehole beneath the packer.

Figure 1 is a longitudinal section view of a borehole having modified tubing installed;

Figure 2 is a longitudinal section view of the borehole with a pump being disposed in the tubing;

Figure 3 is a longitudinal section view of the borehole with the pump being pump being installed in the tubing;

Figure 4 is a longitudinal section view of a borehole with another embodiment of the pump and tubing;

Figure 5 is a longitudinal section view of a borehole with a further embodiment of the pump and tubing;

Where equivalent components appear in different embodiments, the same designating numeral will be used.

Referring to figure 1, a gas production tube 10 is disposed in a borehole 20 of a gas well. The gas production tube 10 is substantially concentric with the borehole 20 so that an annulus 22 exists between the casing of the borehole 20 and the gas production tube 10. The gas production tube 10 is sealed against the casing of the borehole 20 by a packer 12. The gas production tube 10 includes gas inlet apertures 14 which allow fluid communication between the inside of the gas production tube 10 and the annulus 22, the gas inlet apertures 14 being located a short distance beneath the packer 12. The lower end of the gas production tube 10 is open.

A pump discharge tube 16 runs along part of the gas production tube 10, ideally located on the gas production tube's outer surface. The upper end of the pump discharge tube 16 is located above the packer 12 and is open to the annulus 22. The pump discharge tube 16 extends past the gas inlet apertures 14, the pump discharge tube's lower end being sealed from the annulus 22 but communicating, via an aperture 17 in the gas production tube's wall, with the inner bore of the gas production tube 10.

An electrical power line 18 is also attached to the outside of the gas production tube 10, the line extending between the surface where it can be connected to a power supply, and a point typically beneath the lower end of the pump discharge tube 16. The lower end of the electrical power line 18 terminates with a electrical wet connector 21 that is accessible from the inner bore of the gas production tube 10.

The packer 12 is arranged such that the electrical power line 18 and the pump discharge tube 16 are accommodated without compromising the seal

between the annulus 22 above the packer 12 and the annulus 22 below the packer 12.

The gas production tube 10 also includes an inlet port 19 allowing communication between the bore of the gas production tube 10 and the annulus 22. The inlet port 19 is situated between the pump discharge tube 16 and the electrical wet connector 21.

Referring to figure 2, motor and pump assembly 30 is lowered through the gas production tube 10 using a slickline running tool 24.

The motor and pump assembly 30 includes an electrical contact that engages with the electrical wet connector 21 through an aperture in the gas production tube 10. The connection mechanism illustrated shows a hinged plug 32 attached to the bottom of the motor and pump assembly 30, the hinged plug 32 including a protruding pin 33 that extends radially outwards towards the wall of the gas production tube 10. The motor and pump assembly 30 is kept correctly oriented, by using for example an engaging profile between the motor and pump assembly 30. The gas production tube 10 also includes an inwardly protruding vane 34 having a surface set a shallow angle to the gas prodution tube's axis. Referring to figure 3, when the motor and pump assembly 30 near the desired position, the pin 33 of the hinged plug 32 engages with the inwardly protruding vane, causing the plug 32 to pivot (in an anti-clockwise direction when considered as illustrated in the figures), the gas production tubing in this region having a cut-out portion to accommodate the plug 32. An electrical contact 37 on the hinged plug 32 then engages with the electrical wet connector 21 mounted on the gas production tube 10. In addition to the engagement between the

electrical wet connector 21 and the electrical contact on the hinged plug 32, further engagement means may be provided to support the weight of the motor and pump assembly 30. It will also be realised that other electrical types of connection between the electrical conductor and the motor could be employed.

When the motor and pump assembly 30 has been located in its desired position at the lower end of the gas production tube 10, the slickline running tool 24 is disengaged and retrieved.

The motor and pump assembly 30 comprises a pump 40 connected above and driven by an electric motor 35 (which is supplied from the electrical power line 18 via the electrical wet connector 21 and the electrical contact on the hinged plug 32). When the motor and pump assembly 30 is installed, the pump inlet port 19 is adjacent to the inlet 42 of the pump 40. The outlet 43 of the pump 40 is adjacent to the aperture 17 communicating with the lower end of the pump discharge tube 16. The pump's inlet 42 and outlet 43 are separated by a lower assembly seal 45. An upper assembly seal 44 separates the pump outlet from the bore of the gas production tube 10 above the motor and pump assembly 30.

Gas present in the borehole 20 enters the gas inlet apertures 14 of the gas production tube 10 and travels up the bore of the gas production tube 10 to the surface. When water or another liquid accumulates in the borehole 20 to the level of the pump inlet port 19, the electric pump 40 is operated to draw the water through the pump to exit through the pump's outlet 43 into the portion of the gas production tube 10 between the upper and lower assembly seals 44, 45. The water is then forced through the pump

discharge pipe 16 into the borehole annulus 22, to be removed at the surface of the borehole. The gas produced and the water extracted from the borehole 20 are therefore conveniently transported up the borehole along separate paths.

The water found in coalbed mines often has includes a suspension of coal particles, and the presence of such particules can affect or damage the pump 40. If the pump 40 requires attention or replacement, the slickline running tool 24 may be lowered down the gas production line, to engage with the motor and pump assembly 30. The motor and pump assembly 30 may then be disengaged from the electrical and other connections, and winched to the surface. A repaired or replacement motor and pump assembly may then be deployed in the manner previously described.

Referring to figure 4, in another embodiment the lowest portion of the borehole 20 is sealed by a sump packer 50. The motor and pump assembly 30 is here configured with the pump 40 depending from the motor 35, which is connected to a power supply via the electrical wet connector 21 as previously described. The pump outlet 43 discharges into a flow tube 52 (the pump outlet 43 and flow tube 52 being sealedly connected with respect of the surrounding borehole 20 liquid). The flow tube 52 extends through the sump packer 50. Gas in the borehole 20 above the sump packer 50 from the surrounding formation travels through the gas inlet apertures 14 into the gas production tube 10 as in the previous embodiment. As liquid accumulates in the borehole 20, the pump 40 may be activated, drawing liquid from the section of the borehole 20 in which the motor and pump assembly is situated, and discharging this liquid into the mine's sump beneath the sump packer 50. In this manner, liquid removed from the

borehole, which is often contaminated with hydrocarbons, does not have to be treated or disposed of at the surface.

Referring to figure 5, in another arrangement, the motor and pump assembly 30 are lowered through the borehole 20 until they come to the sump packer 50, where the pump 40 engages with the sump packer 50 so that the pump's outlet 43 is beneath the sump packer 50 (of the course the pump 40 and pump outlet 43 could instead rest upon the sump packer 50 and be sealedly engage with a passage leading through the sump packer). The electric motor 35 is suspended, and electrically connected by a line 55 to the assembly's electrical plug 32 connection module 54, which engages mecahnically with the gas production tube 10 and electrically with the electrical wet connector 21 in the same manner as previously described. The line 55 connecting the electrical plug 32 connection module 54 and the motor and pump assembly 30 must be sufficiently strong to carry the weight of the motor and pump assembly 30.

In this embodiment, the pump inlet 42 is situated very close to the bottom of the portion of the borehole 20 defined by the upper packer 12 and sump packer 50. All but the smallest levels of accumulated liquid can therefore be injected into the zone beneath the sump packer.

It will be seen that for the embodiments where liquid is pumped beneath the sump packer, the annulus of the gas production tube is not required for transport of liquid. These embodiments may be effected less preferably without a gas production tube defining an annulus with the borehole. The installation of the gas production tube and packer to isolate the annulus, and the provision of the gas inlet apertures and pump discharge tube,

together with a suitable sump packer, allows for adaptability of the dewatering process, different methods being adopted at different times or depending upon the characteristics of the well.

Claims

1. A system for removing liquid from a portion of a borehole, comprising

a motor;

a pump;

a tube disposed within the borehole so as to define an annulus between the outer surface of the tube and the wall of the borehole

a packer sealedly separating the annulus above the packer from the lower part of the borehole,

such that gas may be produced up up the bore of the tube, and liquid may be pumped into the annulus above the packer.

2. A system according to claim 1 wherein the motor and pump may be moved along the tube.

3. A system according to any previous claim wherein the motor is an electric motor, and an electric conductor is provided disposed along the tube to supply the motor.

4. A system according to claim 3 wherein the motor and pump include a connection means for electrically engaging with the electric conductor.

5. A system according to any previous claim wherein a conduit passes through the packer to provide fluid communication between the pump and the annulus above the packer.

6. A system for removing liquid from a portion of a borehole, comprising

a tube disposed within the borehole so as to define an annulus between the outer surface of the tube and the wall of the borehole

and a sump packer sealing the sump of the borehole with the borehole above it

such that a motor and pump may be used to direct liquid in the borehole either up the annulus, or below the sump packer.

7. A system for removing liquid from a portion of a borehole, comprising

a motor;

a pump;

a sump packer sealing the sump of the borehole with the borehole above it

the inlet of the pump being in fluid communication with the borehole above the sump packer, and the outlet of the pump being in fluid communication with the borehole beneath the packer.

8. A system according to claim 7 wherein the motor is an electric motor, and an electric conductor is provided disposed along the tube to supply the motor.

9. A system according to either claim 7 or 8 wherein the pump includes a conduit running from the outlet of the pump and through the sump packer.

10. A system according to any of claims 7, 8 or 9 wherein the pump extends through the packer, with the outlet of the pump situated beneath the bottom of the packer.

11. A system according to claims 8 and 10 wherein the motor is attached to the pump, and an electric cable extends between the electric conductor disposed along the tube and the motor.

12. A tube installed in a borehole to define an annulus, having a packer sealedly separating the annulus above the packer from the lower part of the borehole, the tube being adapted for use in any previous claim.

13. A system, and method of operating the system, as described and illustrated herein.

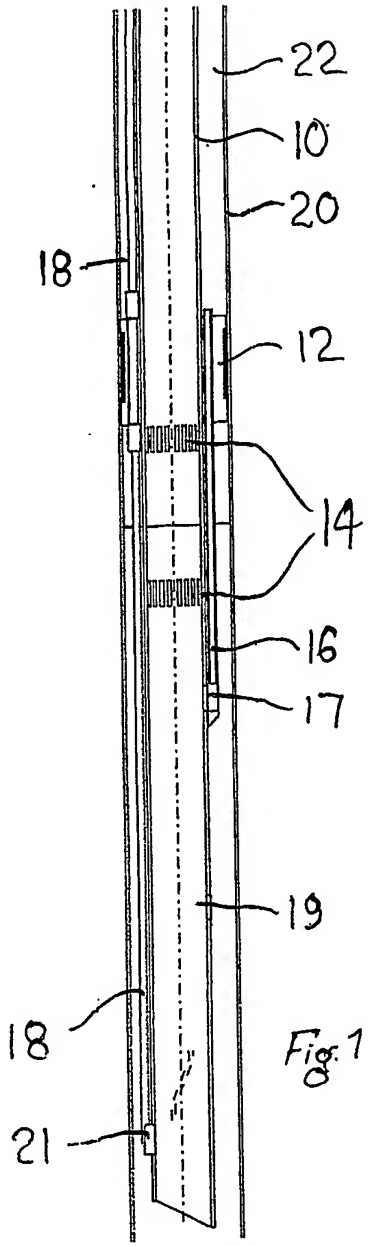

Fig. 1

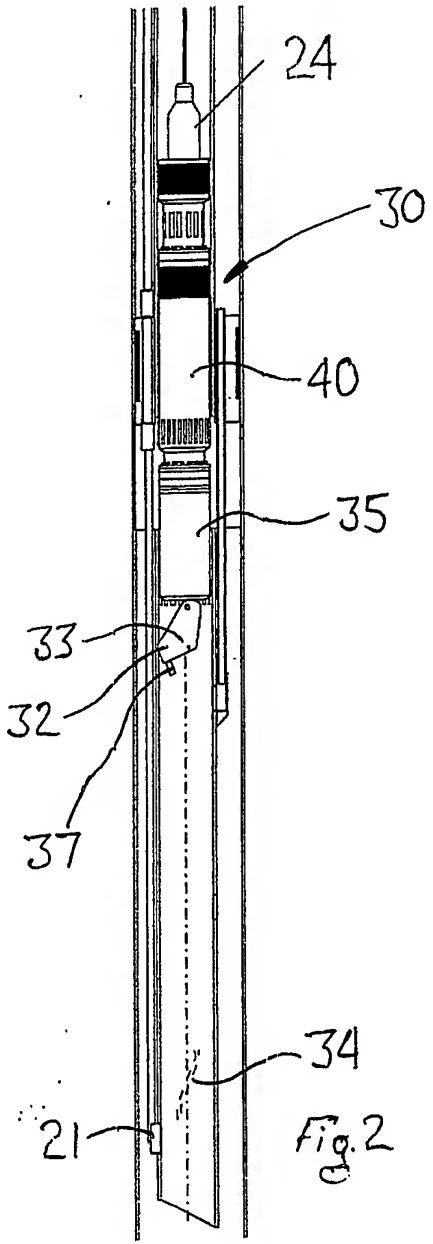

Fig. 2

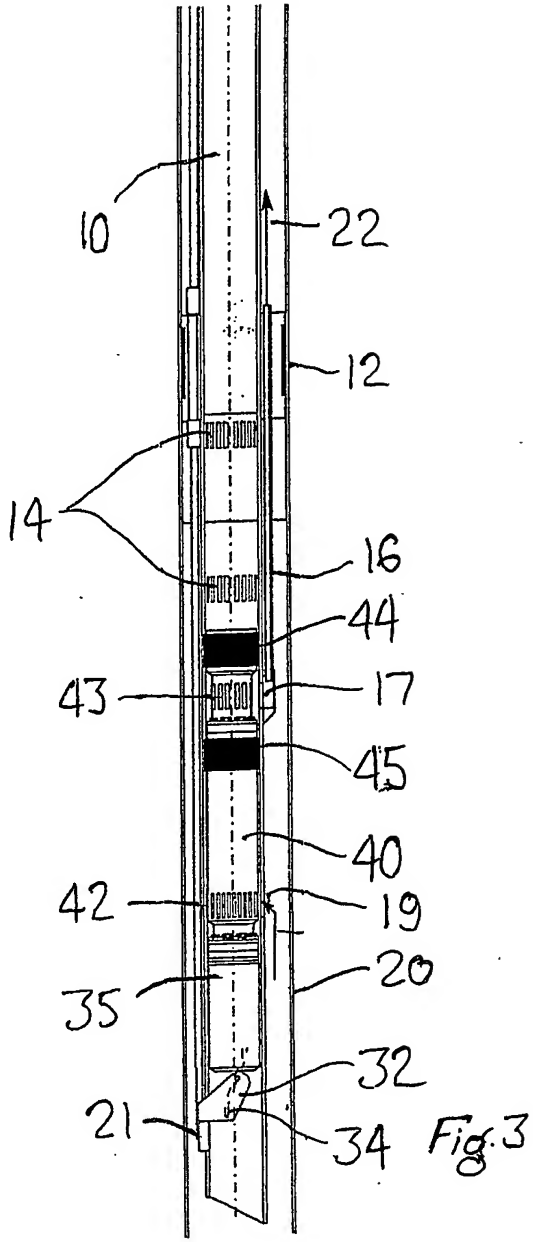

Fig. 3

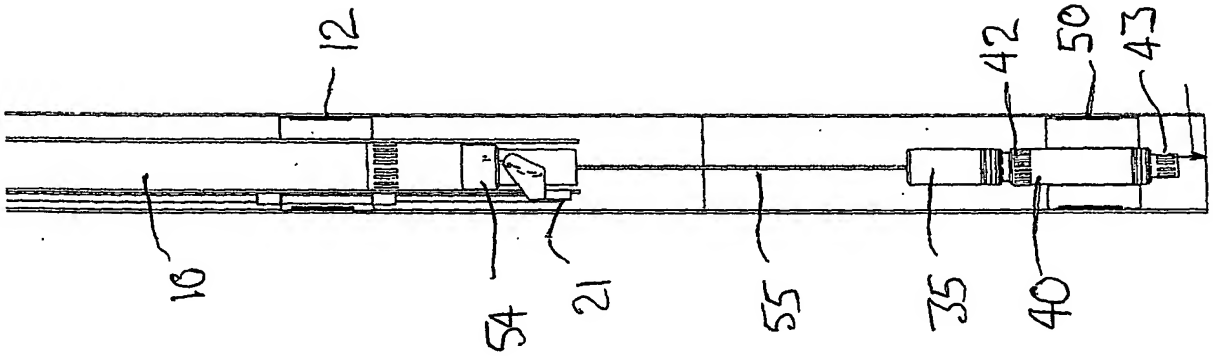

Fig. 5

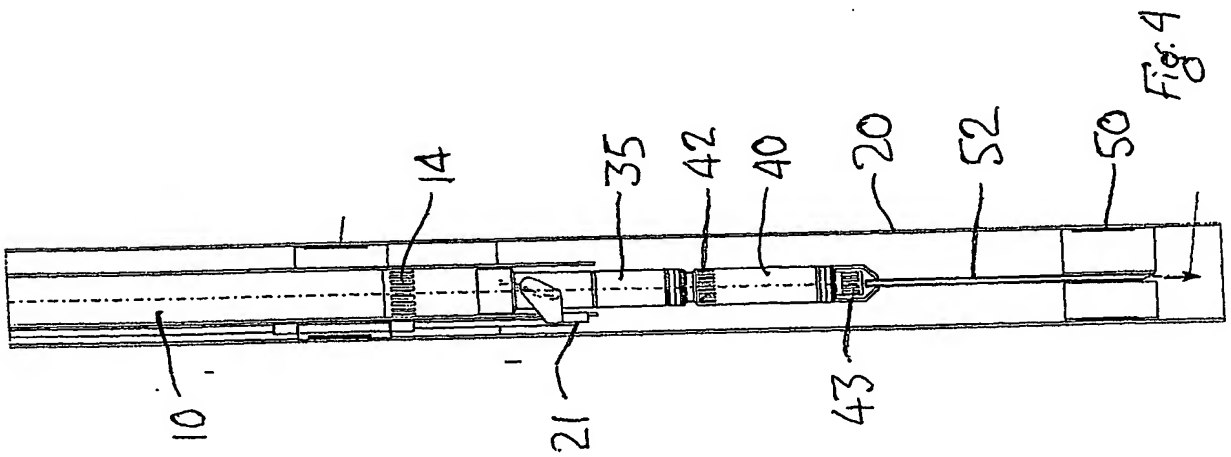

Fig. 4